Relevance of Internet data on Dentistry in Global Countries using the Google Trends Approach

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Article Info	ABSTRACT
	Aim: The purpose of current study was to compare Google Trends (GT) values on dental terms (dental caries, toothache, dentist, teeth whitening, and toothbrush) with countries' gross domestic product (GDP) and population. **Materials and Methods:** Dental terms of the GT values "dental caries, toothache, dentist, teeth whitening, and toothbrush" were obtained through the GT application, including "All categories and search sources." The findings were obtained for 49 countries from around the world with data. The GDP and population values of the countries analyzed were used. Spearman correlation was used to investigate the correlation between dentistry-related data and the GDP and population values of the countries ($p < 0.05$). **Results:** The positive moderate correlations between GDP and toothbrush values were statistically significant ($r=0.582$; $p<0.001$). The positive moderate correlation between GDP and dentist values was statistically significant ($r=0.615$; $p<0.001$). The negative moderate correlation between GDP and toothache values was statistically significant ($r=-0.476$; $p=0.001$). The negative correlation between dentist and population values was statistically significant ($r=-0.398$; $p=0.005$). The positive moderate correlation between dentist and toothbrush values was statistically significant ($r=0,632$; $p<0,001$). The negative moderate correlation between dentist and dental caries values was statistically significant ($r=-0,403$; $p<0,001$). **Conclusion:** Individuals who care about oral health search more for terms such as toothbrush and teeth whitening and less for terms such as dental caries and toothache. Moreover, individuals in countries with a high GDP are significantly less likely to search online for terms such as toothache.

Google Trends Yaklaşımı Kullanılarak Ülkelerdeki Diş Hekimliğine İlişkin İnternet Verilerinin Değerlendirilmesi

Makale Bilgisi	ÖZET
	Amaç: Bu çalışmada diş hekimliği (diş çürüğü, diş ağrısı, diş hekimi, diş beyazlatma ve diş fırçası) ile ilgili Google Trends (GT) verilerininin, ülkelerin gayri safi yurtiçi hasılası (GSYH) ve nüfusu ile ilişkisini değerlendirilmesi amaçlandı. **Gereç ve Yöntemler:** "Diş çürüğü, diş ağrısı, diş hekimi, diş beyazlatma ve diş fırçası" terimleri için GT değerleri, "tüm kategoriler ve arama kaynakları" GT uygulaması aracılığıyla elde edildi. Dünya çapında yeterli veriye sahip 49 ülke için arama sonuçları kaydedildi. Analiz edilen ülkelerin GSYH ve nüfus sayıları kullanıldı. Diş hekimliğine ait GT verileri ile ülkelerin GSYH ve nüfusa ait değerler arasındaki korelasyonu araştırmak için Spearman korelasyonu kullanıldı ($p<0,05$). **Bulgular:** GSYH ve diş fırçası değerleri arasında pozitif orta korelasyon istatistiksel olarak anlamlıdır ($r=0,582$; $p<0,001$). GSYH ile diş hekimi değerleri arasında pozitif orta korelasyon istatistiksel olarak anlamlıydı ($r=0,615$; $p<0,001$). GSYH ile diş ağrısı değerleri arasında negatif orta korelasyon istatistiksel olarak anlamlıdır ($r=-0,476$; $p=0,001$). Diş hekimi ile nüfus değerleri arasında negatif korelasyon istatistiksel olarak anlamlıdır ($r=-0,398$; $p=0,005$). Diş hekimi ile diş fırçası değerleri arasında pozitif orta korelasyon istatistiksel olarak anlamlıdır ($r=0,632$; $p<0,001$). Diş hekimi ile diş çürüğü değerleri arasında negatif orta korelasyon istatistiksel olarak anlamlıdır ($r=-0,403$; $p=0,004$). **Sonuç:** Ağız sağlığını önemseyen bireyler diş fırçası ve diş beyazlatma gibi terimleri daha çok araştırmaktadır, diş çürüğü ve diş ağrısı terimleriniyse daha az araştırmaktadır. Ek olarak, GSYH'si yüksek ülkelerdeki bireyler diş ağrısı terimini internette aramayı anlamlı düzeyde daha az yapmaktadır.

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INTRODUCTION

Oral and dental diseases, which are among the most common health problems worldwide, affect the general health of individuals and create a serious economic burden on individuals.[1] Oral diseases can cause serious health problems. Thus, good oral hygiene plays an important role in preventing these diseases.[2] Individuals' general health and quality of life are negatively affected by poor oral hygiene.[3] Dental caries is a significant public health burden on individuals worldwide. Dental caries should be taken seriously into consideration, as it negatively affects different age groups and individuals' quality of life.[4] It has been reported that individuals with low socioeconomic status and high caries experience visiting clinics more frequently due to toothache.[5] Toothache is a discomfort caused by a variety of etiologic factors, and the most common cause of this pain is dental caries.[6] Dental caries can be prevented with early diagnosis by an experienced dentist and proper oral hygiene.[4]

Despite improvements in the oral health of individuals worldwide, major oral health challenges persist in countries with different income levels.[7] Research has shown that the delivery of health services to individuals and providing a better quality of life to the public positively affects the economic welfare of individuals.[1] Health systems should have strong components for improving and maintaining health across age groups and facilitating the early detection of diseases and appropriate treatment.[8] A health system should provide staff, funding, information, materials, transportation, communication networks, and financially equitable services. In high-income countries, advanced systems for dental health provide treatment and preventive services to individuals.[9] Moreover, healthcare has become one of the most important fields of study that now has amassed large databases[10], while the number of publications in this field is constantly increasing.[11]

The internet has rapidly become a primary source of health information. Individuals around the world search for health information every day. In particular, individuals can access a large amount of information on the internet for any keyword they want to search.[12] A study has shown that the most frequently searched topics on internet search engines are related to healthcare terminologies.[13] The most popular tool for using web-based data on internet searches is Google Trends (GT).[10] GT is a service that provides users with statistical information such as the geography, languages, and frequency of searches for a word or phrase in the Google search engine. Thus, GT allows users to evaluate how many times a word is searched on Google and its popularity. GT data, which are publicly available, can be collected and stated in real time.[14] Moreover, GT is a reliable tool for predicting changes in human behavior. If search terms are carefully chosen, they can be accurately measured using Google data.[10] GT is valid, accurate, and useful for forecasting and offers new opportunities for big data. Therefore, there is great potential in using web-based queries to study topics that are difficult or even impossible to investigate without the use of big data.[10]

Given the diversity of topics for which GT data has been used to examine changes in interests up to this point and the usefulness of this tool in assessing human behavior, it is clear that it is indeed valuable in discovering and predicting behavioral trends of individuals.[10] It can also be a useful tool for analyzing the popularity of internet search queries. Therefore, the aim of our study was to evaluate the relationship between dentistry-related GT data (dental caries, toothache, dentist, teeth whitening, and toothbrush) and countries' gross domestic product (GDP) and population. The null hypothesis of our study was that there will be

no significant relationship between the GT data on dentistry and the GDP and population of countries.

MATERIALS AND METHODS

As we used only publicly available information in the study, we did not deem it necessary to obtain approval from an ethics committee. The GT online search tool analyzes search terms based on their total search volume, providing data on the relative popularity of a search term in a given region and time. However, it also allows for the measurement of the relative popularity of search terms within a given category, place, and time range by providing information on their popularity at a given time. Relative search volume (RSV) is a measure of relative popularity, represented on a scale of 0–100 (with 100 indicating the highest relative popularity).[15] GT values (GTv) were taken as the basis for RSV values in the study.

Access to the GT application for the current study was on March 15, 2024. Values related to dental caries, toothache, dentist, teeth whitening, and toothbrush were collected worldwide (2023). Search results for all keywords were recorded in 49 countries with sufficient data. Data were linked to the population, and the countries' latest GDP and population numbers were retrieved from the internet website.[16,17] On the Internet, GDP and population values are updated over time. In GT, topics are a group of terms that share the same concept in any language. Topics can be found under your search term. For example, if you search for London and select the related topic, you may see sub-topics such as "The capital of the United Kingdom" and "Londres," which means "London" in Spanish, in your search results.[18]

Statistical Analysis

The data were analyzed using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA). Spearman's correlation was used to evaluate the relationship between the obtained data. Additionally, correlation matrix plot graphs were prepared using the Minitab 19 statistical program, depicting the examined terms, GT values, population, and GDP by province (Figure 1). The significance value in this study was accepted as $p < 0.05$.
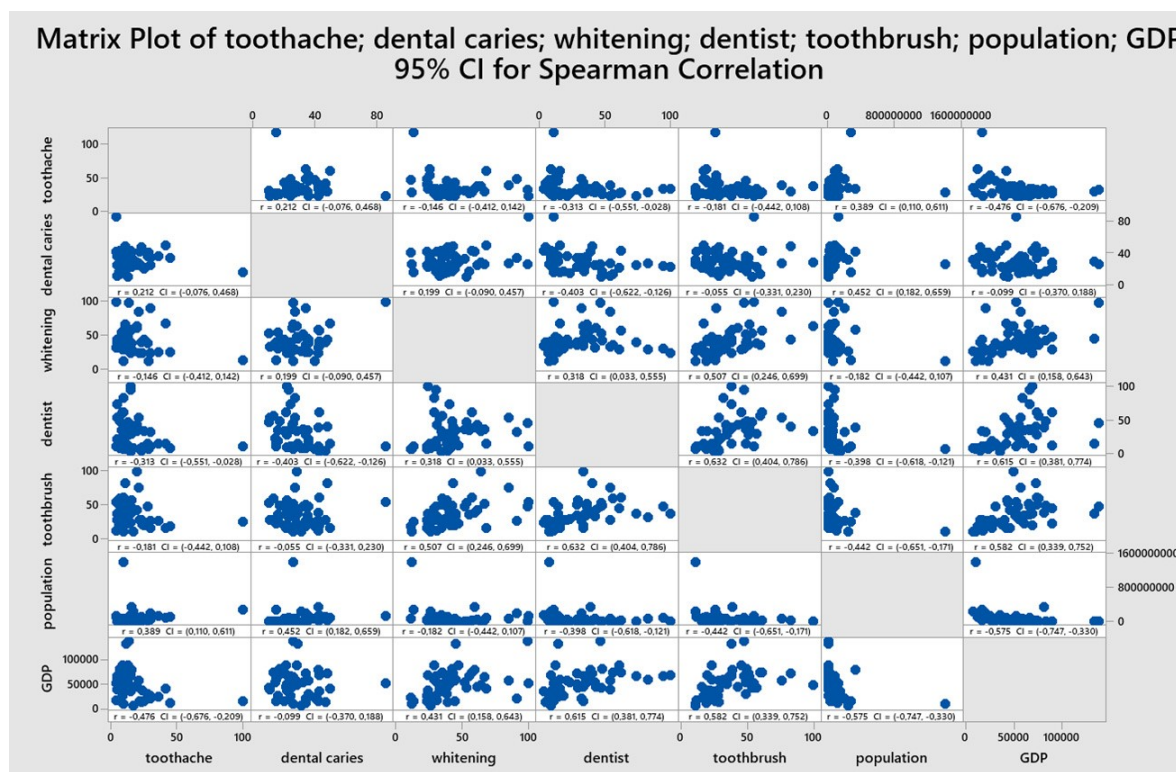

Figure 1: *Matrix plot of values for Gross Domestic Product (GDP), population and dental terms*

RESULTS

GT values (GTv), population values, and GDP values of the terms analyzed by country are shown in Table 1. When searching for "toothache," the highest value was found in Indonesia (100) and the lowest in Japan (4) and Egypt (4). When searching for "toothbrush," the highest value was found in Czechia (100) and the lowest in India (11) and Pakistan (11). For the search "dentist," the highest value was found in Austria (100) and the lowest in Russia (3). For the search for "dental caries," the highest value was found in Japan (86) and the lowest in Hungary (10). When "teeth whitening" was searched, the highest value was found in Japan (100) and the lowest in Thailand (11). The correlations of the analyzed parameters is shown in Table 2. The negative medium correlation between the GDP and population GTv was statistically significant ($r = -0.575$; $p < 0.001$). The positive moderate correlation between GDP and teeth whitening GTv was statistically significant ($r = 0.431$; $p = 0.002$). The positive moderate correlation between GDP and toothbrush GTv was statistically significant ($r = 0.582$; $p < 0.001$). The positive moderate correlation between GDP and dentist GTv was statistically significant ($r = 0.615$; $p < 0.001$). The negative moderate correlation between GDP and toothache GTv was statistically significant ($r = -0.476$; $p = 0.001$). The negative moderate correlation between toothbrush and population GTv was statistically significant ($r = -0.442$; $p = 0.001$). The negative moderate correlation between dentist values and population GTv was statistically significant ($r = -0.398$; $p = 0.005$). The positive moderate correlation between dental caries values and population GTv was statistically significant ($r = 0.452$; $p = 0.001$). The positive moderate correlation between toothache and population GTv was statistically significant ($r = 0.389$; $p = 0.006$). The positive moderate correlation between toothbrush and teeth whitening values was statistically significant ($r = 0.507$; $p < 0.001$). The negative moderate correlation between dentist and teeth whitening GTv was statistically significant ($r = 0.318$; $p = 0.026$). The positive moderate correlation between dentist values and toothbrush GTv was statistically significant ($r = 0.632$; $p < 0.001$). The negative moderate correlation between dentist GTv and dental caries values was statistically significant ($r = -0.403$; $p = 0.004$). The negative moderate correlation between dentist and toothache GTv was statistically significant ($r = -0.313$; $p = 0.028$).

Table 1: Google Trends values of the countries included in the study, population, Gross Domestic Product (GDP) values, and dental terms

Country	Toothache	Dental caries	Teeth whitening	Dentist	Toothbrush	Population	GDP
Indonesia	100	15	13	10	26	279118866,00	15834,00
Philippines	45	34	25	8	19	110683773,00	11326,00
Türkiye	42	50	68	15	17	85372377,00	41888,00
Mexico	36	36	25	14	27	129406736,00	24976,00
Argentina	30	24	23	10	17	46044703,00	26506,00
Brazil	30	34	91	32	27	203062512,00	20079,00
Thailand	29	40	11	7	19	65988650,00	22491,00
Chile	28	36	38	14	49	19960889,00	29935,00
South Africa	25	20	44	33	20	60604992,00	16211,00
Malaysia	24	22	24	9	22	33500000,00	37083,00
Vietnam	23	47	39	4	29	100000000,00	14285,00
Peru	22	42	23	6	28	33396698,00	15894,00
United Kingdom	21	27	85	54	76	67026292,00	56836,00
Czechia	20	28	64	33	100	10827529,00	49030,00
Poland	20	25	61	43	43	37726000,00	45538,00
Pakistan	17	31	26	8	11	241499431,00	6773,00
USA	16	42	59	39	39	336080688,00	80412,00
Slovakia	16	22	38	29	57	5428792,00	42228,00
Russia	15	43	34	3	25	146424729,00	35310,00
Germany	15	23	30	95	48	84607016,00	66038,00
Austria	15	22	24	100	38	9159993,00	69069,00
Ireland	14	26	99	46	48	5123536,00	137638,00
Spain	14	22	40	28	35	48345223,00	50472,00
Hong Kong	14	34	35	28	51	7333200,00	72861,00
United Arab Emirates	13	28	47	12	23	9282410,00	88962,00
Hungary	13	10	53	47	54	9678000,00	43601,00
New Zealand	13	32	52	36	49	5199100,00	53809,00
Singapore	12	29	45	14	38	5453600,00	133108,00
Canada	12	35	45	35	35	40027242,00	59813,00
Australia	11	26	67	36	52	26707556,00	64675,00
Taiwan	11	48	43	40	83	23420442,00	72485,00
France	10	27	29	83	32	68226000,00	58765,00
Italy	10	25	31	42	34	58919345,00	54259,00
India	10	26	12	7	11	1412604531,00	9183,00
Netherland	10	43	57	62	61	17947684,00	73317,00
Portugal	9	21	34	33	16	10467366,00	45227,00
Israel	9	14	37	23	30	9740480,00	54771,00
Serbia	9	16	30	18	28	6647003,00	26074,00
Switzerland	9	21	29	61	46	8865270,00	89537,00
Sweden	8	16	55	34	37	10545310,00	66209,00
Denmark	7	13	35	56	60	5961249,00	74958,00
Norway	7	17	42	48	50	5514042,00	82236,00
Saudi Arabia	7	43	41	8	20	32175224,00	68453,00
Finland	6	15	39	15	23	5581767,00	59869,00
Belgium	5	24	40	74	38	11808859,00	65813,00
South Korea	5	36	44	21	29	51439038,00	56709,00
Greece	5	11	33	54	29	10482487,00	39864,00
Japan	4	86	100	10	55	124500000,00	52120,00
Egypt	4	42	31	10	12	105373154,00	17123,00

Table 2: Correlation values of Google Trends values for Gross Domestic Product (GDP), population and dental terms

	GDP	Population	Tooth Whitening	Toothbrush	Dentist	Dental caries	Toothache
GDP	-	-	-	-	-	-	-
Population	r=-0.575** p<0.001	-	-	-	-	-	-
Whitening	r=0.431** p=0.002	r=-0.182 p=0.212	-	-	-	-	-
Toothbrush	r=0.582** p<0.001	r=-0.442** p=0.001	r=0.507** p<0.001	-	-	-	-
Dentist	r=0.615** p<0.001	r=-0.398** p=0.005	r=0.318* p=0.026	r=0.632** p<0.001	-	-	-
Dental caries	r=-0.099 p=0.5	r=0.452** p=0.001	r=0.199 p=0.171	r=-0.055 p=0.706	r=-0.403** p=0.004	-	-
Toothache	r=-0.476** p=0.001	r=0.389** p=0.006	r=-0.146 p=0.316	r=-0.181 p=0.213	r=-0.313* p=0.028	r=0.212 p=0.143	-

**Correlation is significant at 0.01 level. *Correlation is significant at 0.05 level.

DISCUSSION

In this study, correlations were found between the analyzed dental terms-related GT data of the studies countries for the year 2023 and the GDP data at the relevant times and population of the countries. Therefore, the hypothesis tested in the study was rejected.

Low-income countries have significantly fewer dentists than both middle- and high-income countries.[1] When our findings were analyzed, a positive correlation was found between the GDP and dentist values. An increased search for a dentist GT values decreased toothache GT values searches. In a study, it was reported that individuals with low education levels or low incomes had a higher caries risk in terms of caries experience.[19] Individuals' education level, income, and place of residence indicate their socioeconomic level. These factors are recognized as the strongest determinants of caries formation.[20] In high-income countries, preventive measures are more common and prevent the beginning or progression of caries.[1] However, access to high-quality oral care is more difficult to obtain in low-income countries than in high-income countries, and this has contributed to the global neglect of oral health.

Dental caries is one of the most common major complaints of patients, affecting people from a wide range of age groups and ethnic origins.[21] Although caries is asymptomatic in its initial stages, it is associated with a reduced quality of life for affected individuals.[22] We found that related online queries possibly indicate that web users' relevant search queries are often single or multiple cavitation and dental caries. The fact that tooth decay is a technical term may have created a high variation in search graphs due to the fact that the patient may have been questioned about the diagnosis in the dental office.[23] Treatment of oral diseases is extremely costly in many industrialised countries and difficult in most low- and middle-income countries.[24] This reason the income level of countries geographical situation is further complicated by the pace of economic development and rapid changes in habits and nutrition in many countries.[25] The GDP is a strong predictor in assessing the effects of the social environment and individual factors on dental pain and dental caries.[26] Toothache is still common among children and adolescents and is strongly associated with dental caries, especially in groups of low socioeconomic status.[27] Similarly, toothache and dental caries are most frequently associated with reduced oral health-related quality of life in adults.[25] Caries

has a negative impact on health, as children with poor oral health have higher school absences and perform worse than children with better oral health.[25] In addition, the decline in health systems in many areas of the world may hinder access to oral health services, potentially increasing the risk of dental caries and consequently the occurrence of dental pain.[28]

The importance of oral care products has increased over time due to increased awareness among consumers and better dissemination of information in developing countries. The reason for the increased use of these products is due to the fact that oral diseases can be prevented or treated with the use of oral care products.[29] When our findings were evaluated, it was found that there was a positive relationship between the data of teeth whitening, toothbrush, and dentist terms in countries with high GDP. However, there was a negative relationship between GDP and the toothache search terms. Patthi et al. reported that the search term "dental caries" was highly queried by individuals.[23] Individuals in countries with low GDP may be thought to question internet search preference more when there is a specific disease finding. In addition, a positive relationship was found between tooth whitening and toothbrush data as well between toothbrush and dentist data. This suggests that individuals in countries with high GDP can access oral care products more easily. The findings of our study align with those of another study that reported that individuals with low socio-economic status had low oral hygiene.[30] In our study, the positive correlation between GDP and oral care product search values indicates that dental caries and toothaches may affect internet search values. We also found a negative correlation between toothbrush and toothache and between dentist and toothache. In a previous study, it was found that individuals searching for the term toothache queried terms aimed at preventing toothache.[12] In support of other published research findings,

our study found that individuals who cared about oral health searched more for the terms dentist and toothbrush and less for dental caries and toothache.

Currently, the number of internet users is increasing day by day, and individuals are searching for information on internet search engines.[14] In this study, GT was used to evaluate individuals' search terms. In particular, we showed that GT can be a useful tool for analyzing the popularity of internet searches, with the advantages of easy accessibility and easy reporting of GT data. We determined that by analyzing internet search frequencies and GDP data, it is possible to make an overall assessment of the oral health of individuals in a region. In addition, we found that GT data are a reliable source for obtaining meaningful results, which shows GT can be used as an effective tool for future research.

This study has some limitations. The constant updating of internet data makes it possible to make assessments that are only instantaneous or cover a certain period of time. In addition, the inability to collect data at the specified level in all regions is a limitation of this study. This is because data for the relevant terms were collected from the same countries for these values. In recent years, it has been observed that spending more time on the internet and social media has led individuals to use internet searches to reduce dental health problems. This reflects changing trends in individuals' access to information and greater awareness of oral health. Furthermore, understanding how regional and economic factors influence individuals' demands for dental care can provide important information for more effective resource allocation and service planning. The results obtained through GT cannot replace epidemiological data but can provide a broad perspective for analysis in the area of interest based on internet search results.

CONCLUSION

The GT application can provide valuable insights into emerging diseases and their search analysis across populations. We found that individuals who care about oral health search more for issues such as toothbrush and teeth whitening and less for issues such as tooth decay and toothache. However, individuals in countries with a high GDP search less online for issues such as toothache and dental caries but more for oral healthcare products (toothbrush, teeth whitening). Our findings indicate that awareness-raising activities on dental health will help individuals achieve better oral and dental health.

Ethical Approval

Since sources obtained from humans or animals were not used in this study, ethics committee approval was not obtained.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: SF, MF, Data collection and processing: SF, MF, Analysis and interpretation: SF, MF, Literature review: SF, MF, Writing: SF, MF.

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